

CLIMATE CHANGE AND AGRICULTURE

William Hohenstein

USDA

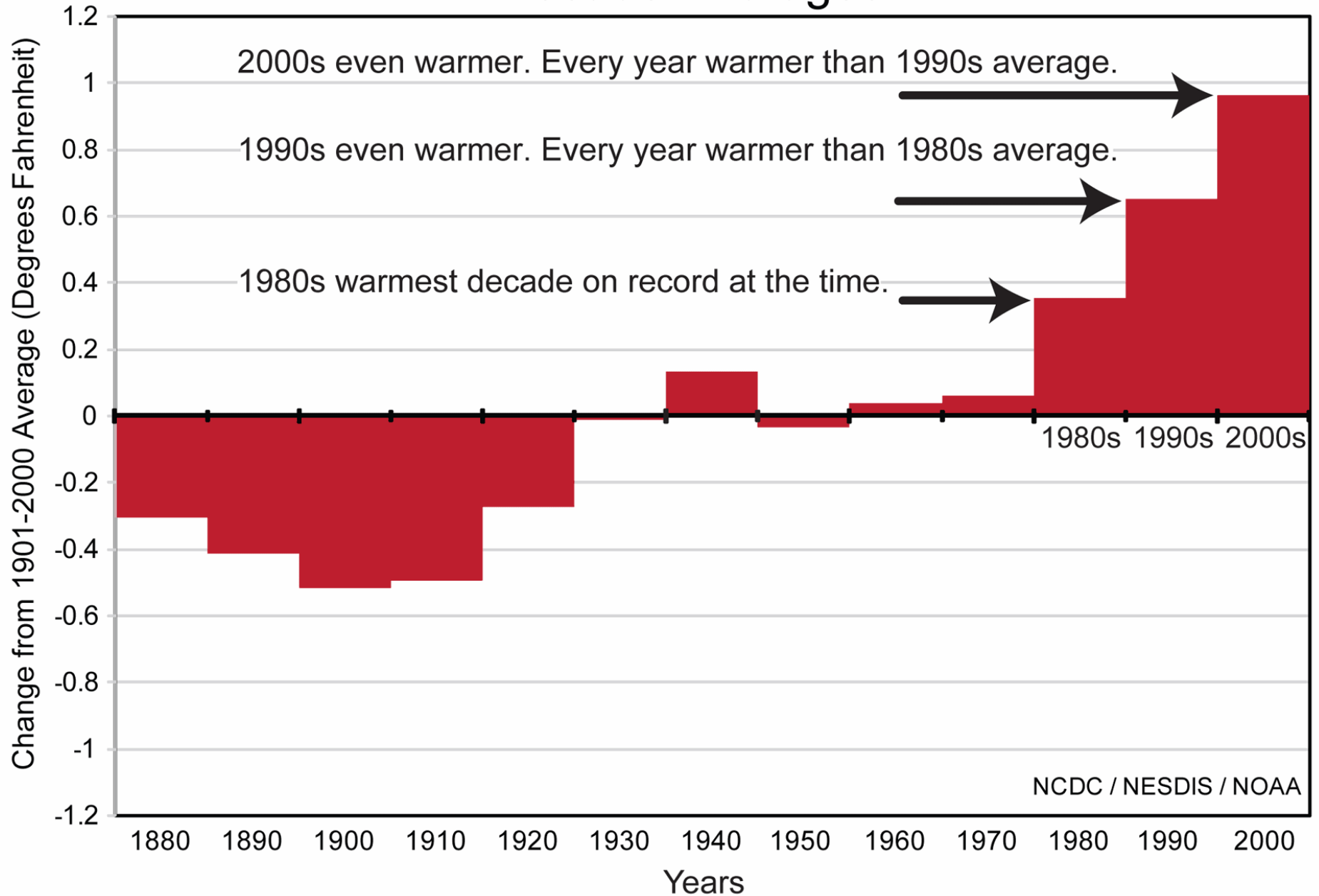
Climate Change Program Office



Why should farmers and ranchers care about climate change?

- **Climate variability, and climate change** have effects on agriculture and land use.
- Crops and grazing lands exist in an atmosphere that is **increasing in concentration of CO₂**.
- Agricultural and forest systems are **important sources of greenhouse gases and carbon sinks**
- Forest and agricultural emission reductions and carbon sinks offer **potentially significant low-cost opportunities** to address climate change

Global Temperature Change Decade Averages



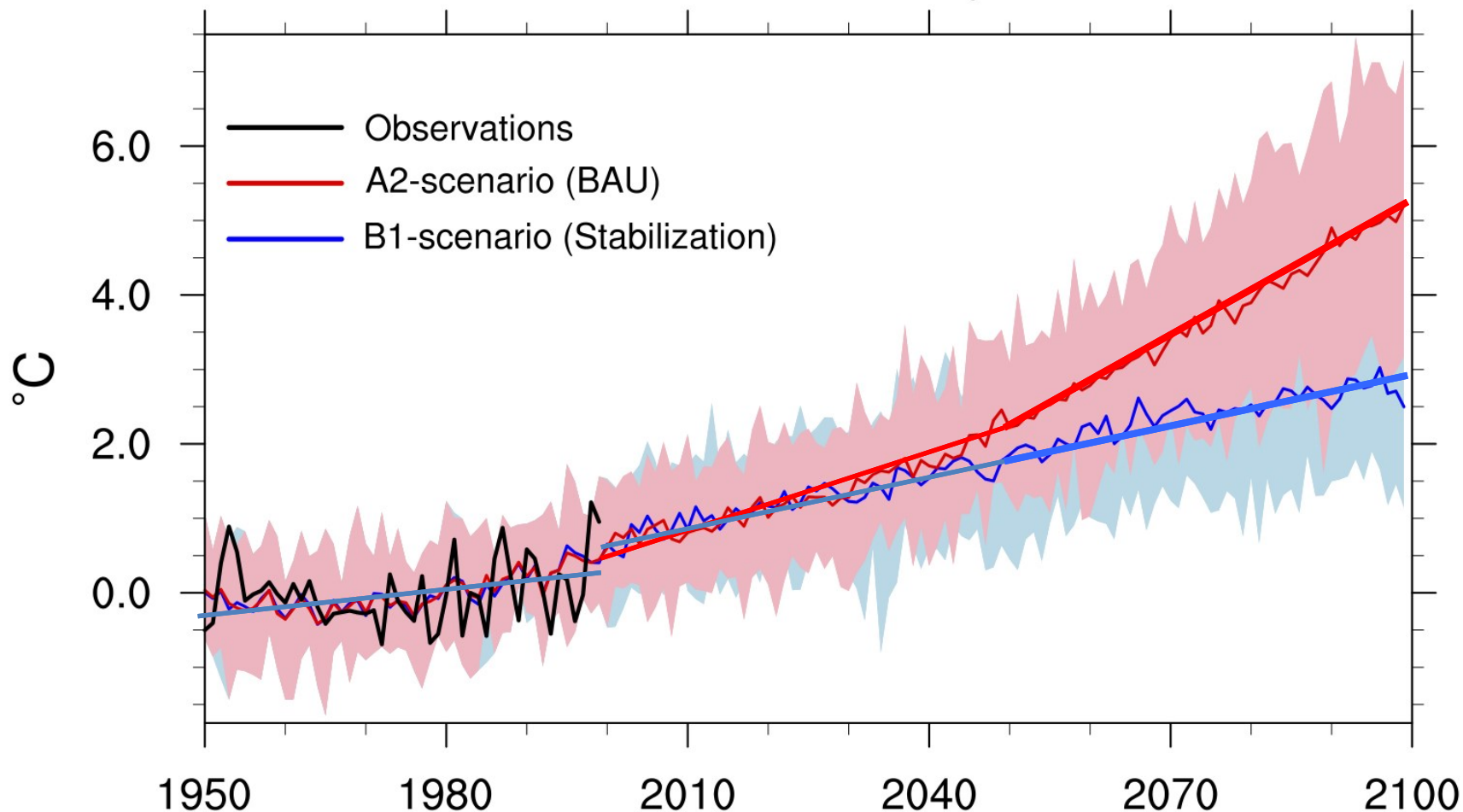


NCAR

Projection US Surface Temperature

Temperature Anomalies ($^{\circ}\text{C}$), 16-Model Ensemble

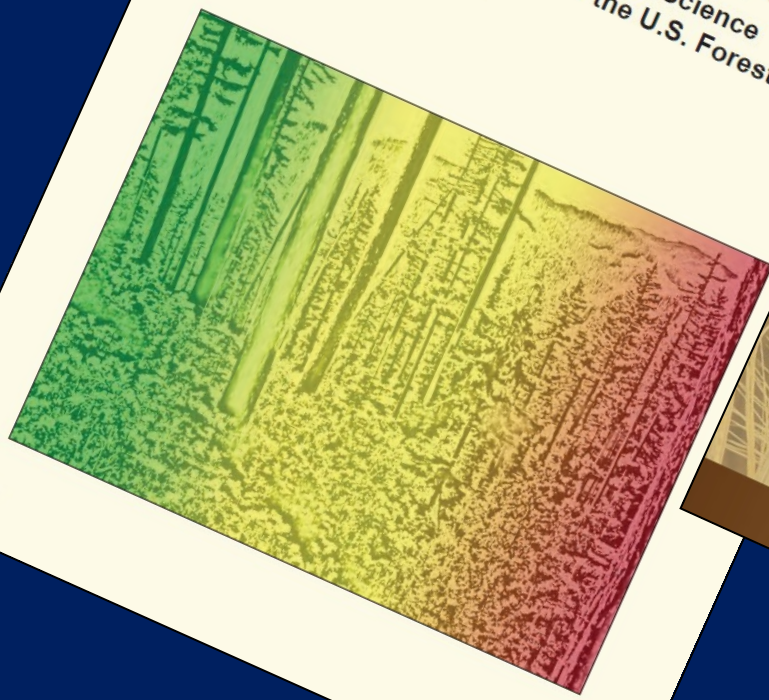
from 1950-1999 average



United States
Department of
Agriculture
Forest Service
Pacific Northwest
Research Station
General Technical
Report
PNW-GTR-870
December 2012



Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the U.S. Forest Sector



United States
Department
of Agriculture
Agricultural
Research Service
Climate Change
Program Office
Technical Bulletin 1983

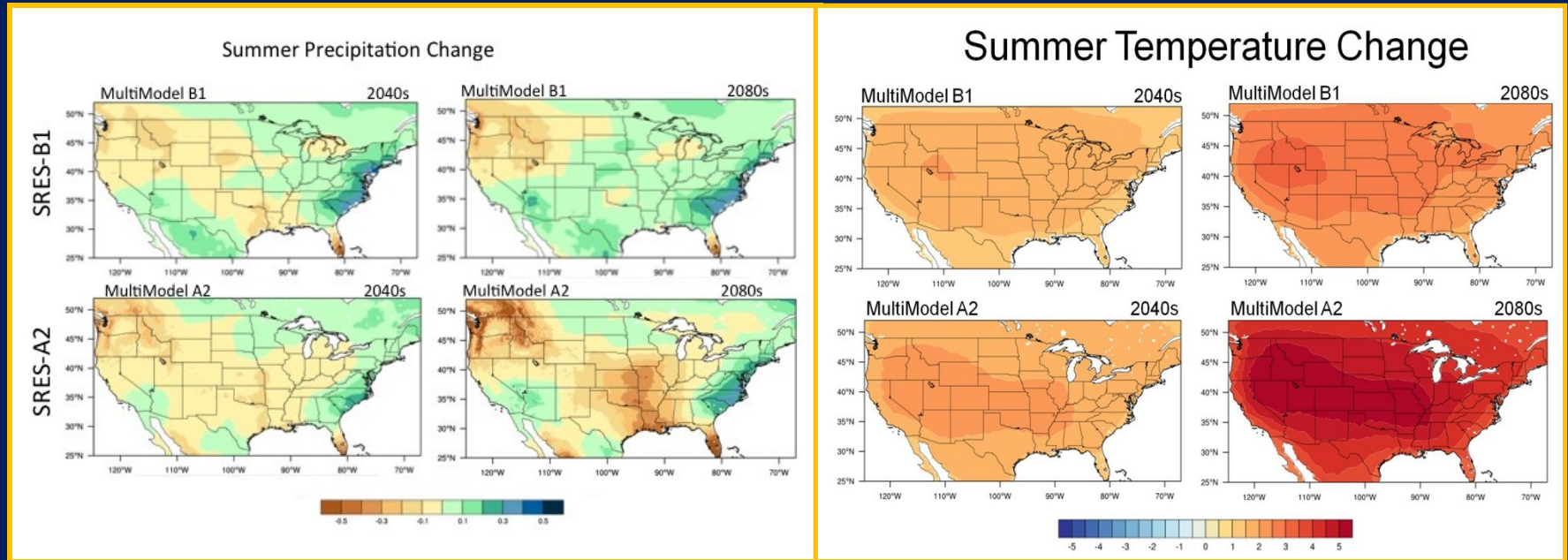


Climate Change and Agriculture in the United States: Effects and Adaptation



http://usda.gov/oce/climate_change/effects.htm

Changing Climate Conditions



- Temperature increases: longer growing seasons, less frost, warmer nights
- Precipitation changes: deficits, excesses, timing shifts, changing mix of rain/snow
- Increased intensity of precipitation events: more flooding and more droughts
- Increasing carbon dioxide concentrations

Effects and Sensitivity Vary by Commodity

- **Corn**: high nighttime temperatures, high temperatures during pollination, water stress
- **Soybean**: water stress, high temperatures
- **Wheat and small grains**: extreme events, frost during flowering, water stress
- **Rice**: temperature extremes during pollination, water management
- **Cotton**: high temperatures during boll fill
- **Pasture and rangeland**: water stress
- **Fruit trees**: chilling requirements not met, high temperatures during fruit development
- **Specialty crops**: water stress, high temperatures



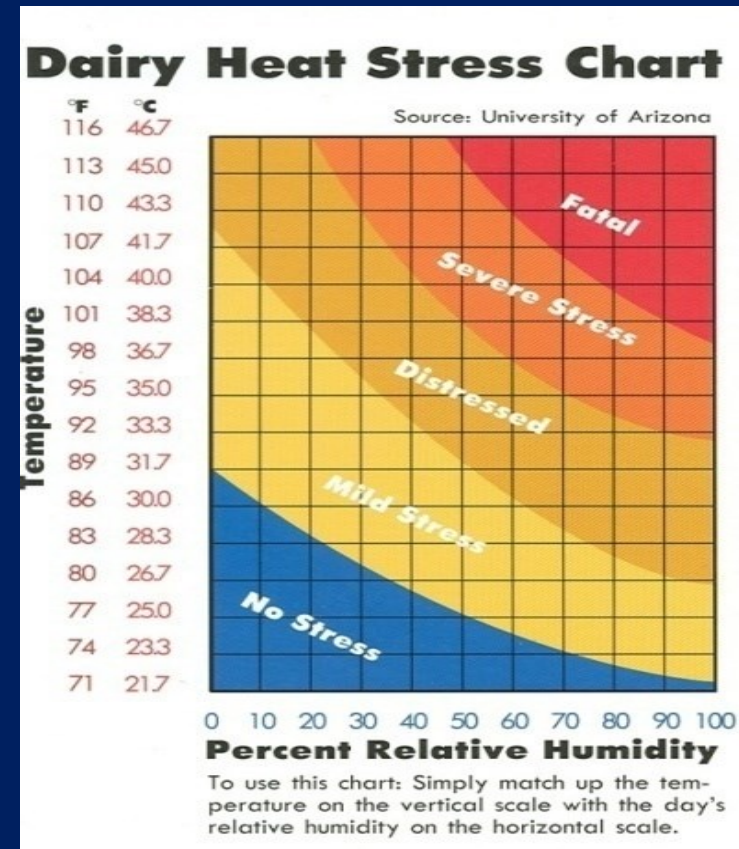
Increased Biotic Stresses Will Significantly Affect Agriculture

- Insect pests
 - Greater numbers, increased insecticide resistance
 - Geographic ranges increases & decreases
 - Imports from foreign sources
- Pathogens
 - Host-pathogen response changes (plants, insects, non-crop reservoirs)
 - Cultural control measures may be less reliable
 - Extreme events can spread
- Weeds
 - Increased vigor, herbicide resistance
 - Geographic range increases & decreases



Livestock Production is Vulnerable

- Feed Grain & Forage
 - Quantity & Quality Decrease
 - Production Cost Increase
- Animal Heat & Humidity Stress
 - Reduces growth, reproduction, production (meat, dairy, eggs)
 - Climate control costs increase
- Disease & Pests
 - Frequency, intensity, distribution
 - Abundance and/or distribution of competitors, predators, & parasites of vectors themselves

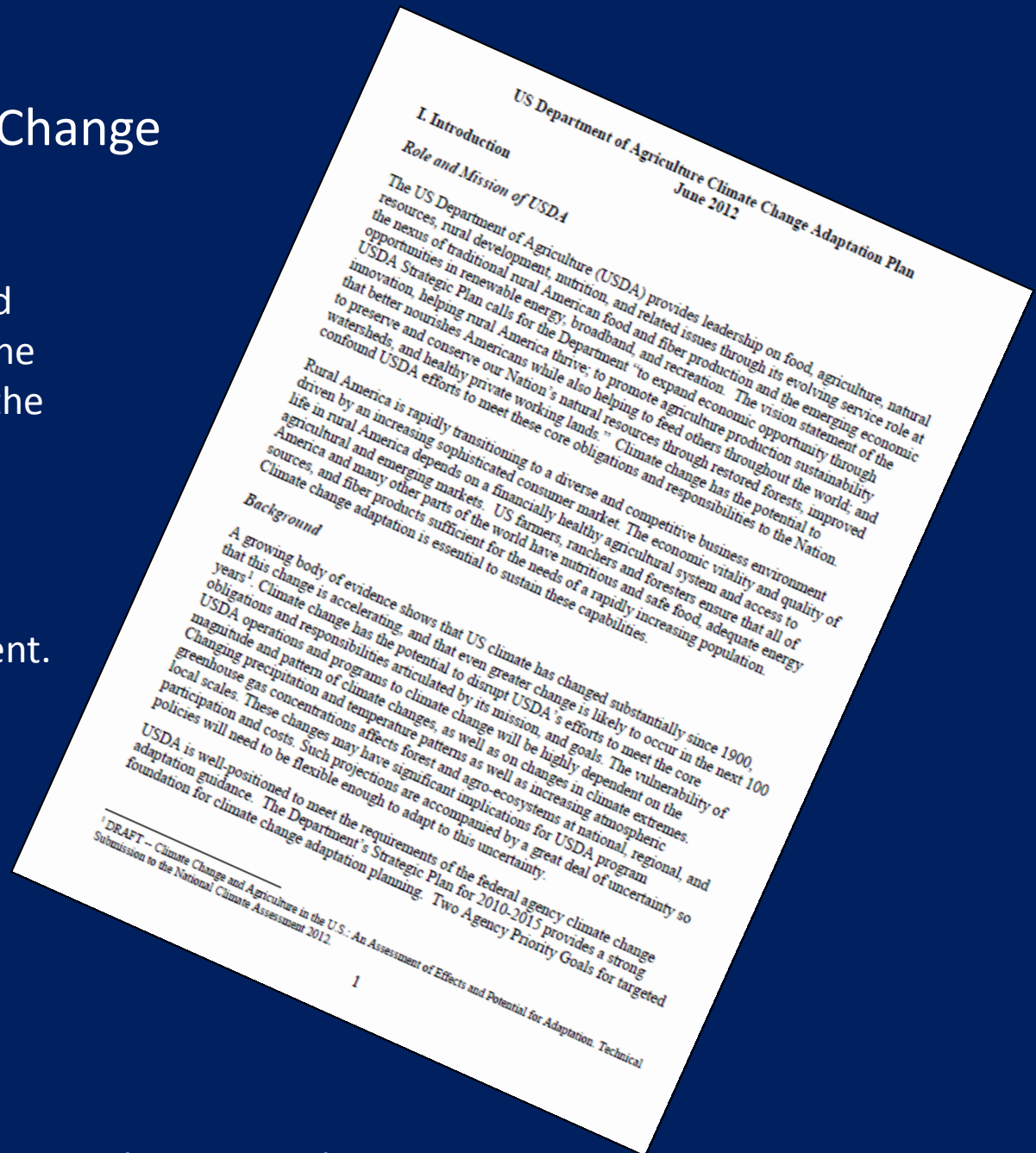


2012 USDA Climate Change Adaptation Plan

Presents vulnerabilities and opportunities for each of the impacted agencies within the Department

Submitted to CEQ

Released for public comment.



Building Agricultural Resilience

- Enhanced understanding of the role of natural resource base (water and soil)
- Understand Potential Exposures
 - Focus on extremes as well as mean changes
- Understand Sensitivities
 - Define critical thresholds & interactions
- Enhance Adaptive Capacity
 - Resilient systems: Climate-ready crops & production systems
- Improved treatment of uncertainty and risk in climate and adaptation decision-making and policy
 - Potential impacts are real but inherently uncertain

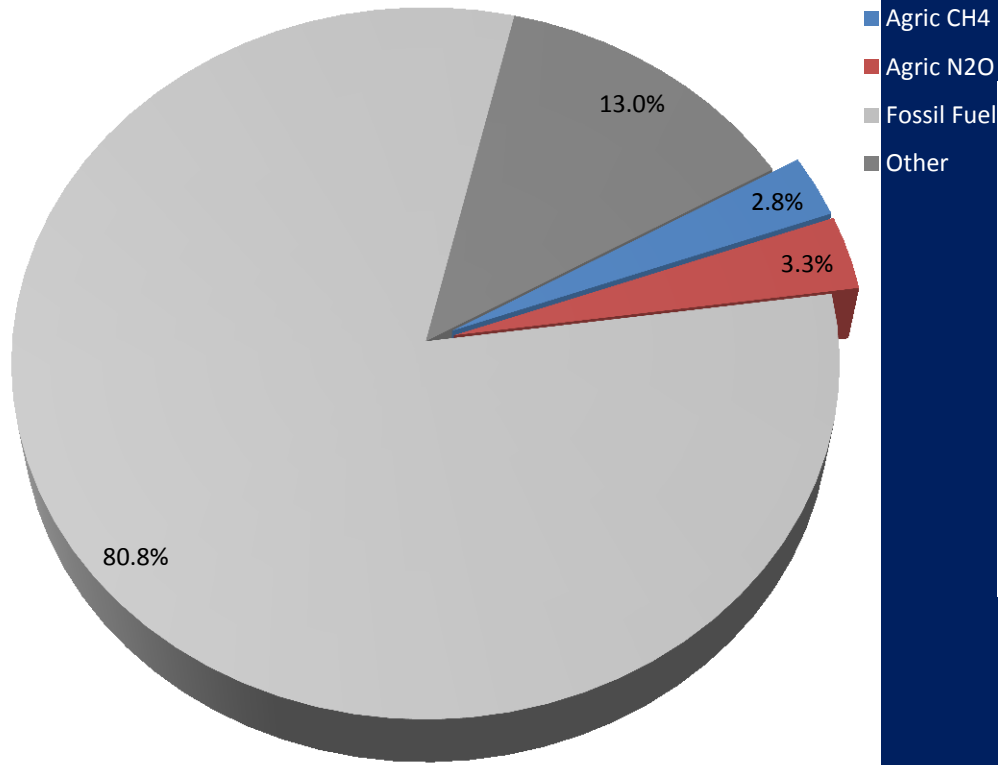
Within the US, in 2008:

Agriculture accounted for 6.1% of total GHG emissions

Carbon sequestration offset 13.5% of U.S. emissions

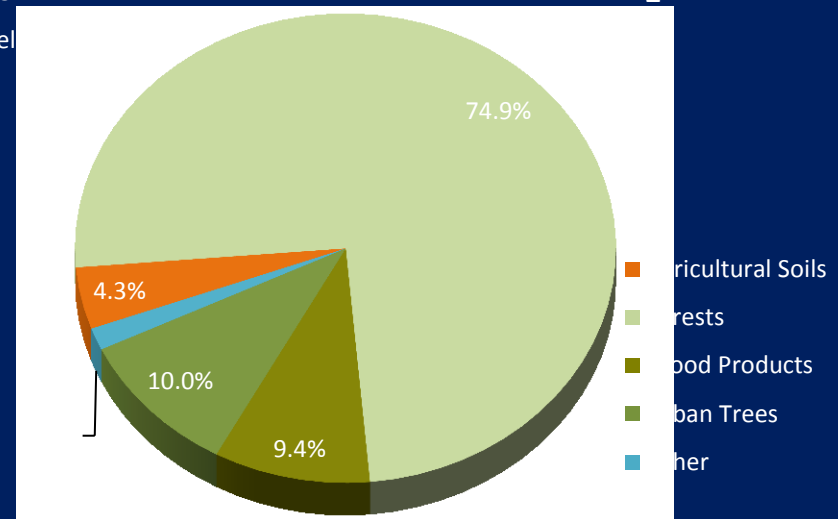
U.S. GHG Emissions:

6.957 billion metric tons CO₂e



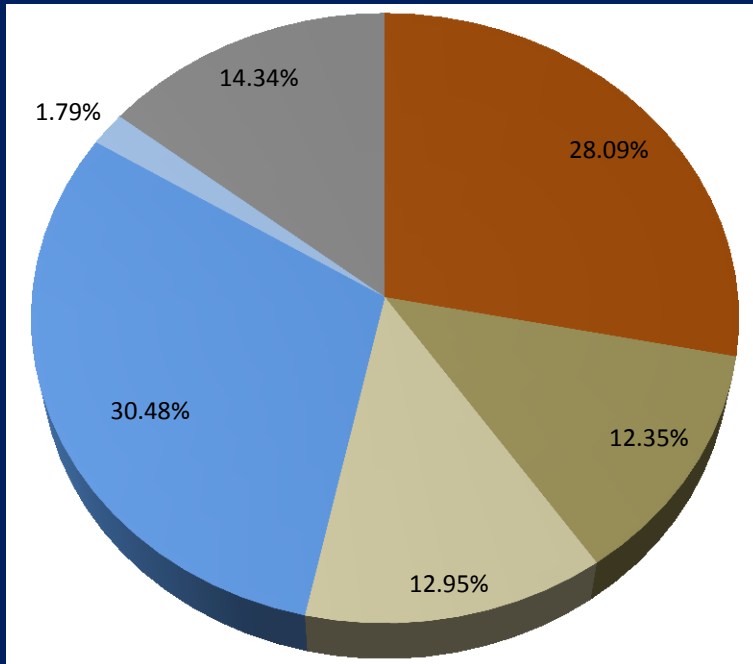
U.S. Carbon Sequestration:

940 million metric tons CO₂e



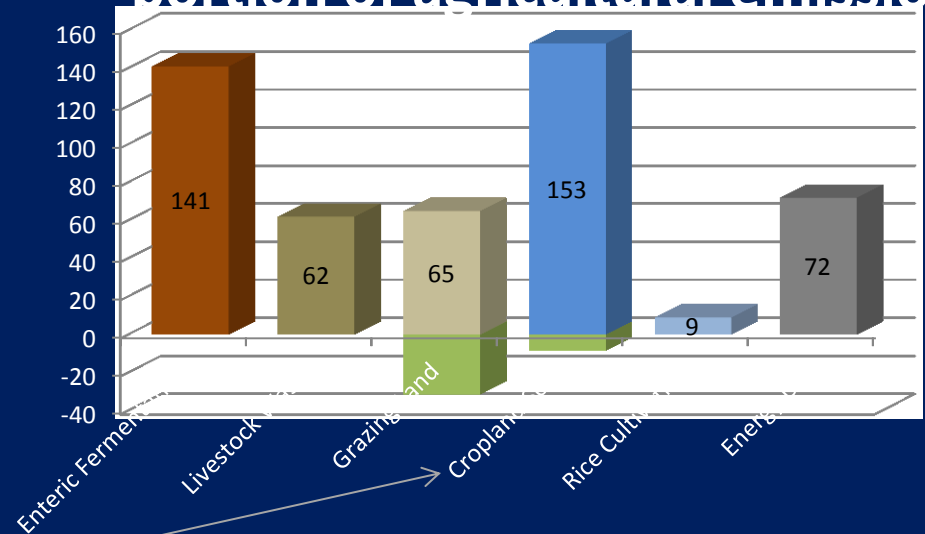
Emissions from agriculture:

About half of emissions are from livestock and grazing.
A third are from cropland nitrogen.



- Enteric Fermentation
- Livestock Waste
- Grazing Land
- Cropland Soils
- Rice Cultivation
- Energy Use

Crop and grazing land soils sequester carbon to offset a portion of agricultural emissions



NOTE: Cropland soils sequestration equals the sum of mineral soils (-42.4 Tg CO₂e) and organic soils (emission of 30.3 Tg CO₂e) and soil liming (emission of 3.8 Tg CO₂e).

Exhibit I-1: Summary of Mitigation Options

Crop Production Systems	Animal Production Systems	Land Retirement Systems
Field Management and Tillage Operations <ul style="list-style-type: none">• Reducing Tillage Intensity• Switch from Conventional to Reduced Tillage• Switch from Conventional Tillage to No-Till• Switch from Reduced Tillage to No-Till	Manure Management <ul style="list-style-type: none">• Covered Lagoon Anaerobic Digester• Complete Mix Anaerobic Digester• Plug Flow Anaerobic Digester• Covering Existing Pond, Tank, or Lagoon• Solids Separator• Nitrification/Denitrification	Land Retirement Systems <ul style="list-style-type: none">• Retire Cultivated Organic Soils and Establish Conservation Cover• Retire Marginal Croplands and Establish Conservation Cover• Restore Wetlands• Establish Windbreaks• Restore Riparian Forest Buffers
Nutrient Management <ul style="list-style-type: none">• Reduce Fertilizer Application Rate• Shift N Application from Fall to Spring• Inhibitor Application• Variable Rate Technology	Grazing Land Management <ul style="list-style-type: none">• Legume Interseeding	

Greenhouse Gas Mitigation Options and Costs for Agricultural Land and Animal Production within the United States



ICF International

February 2013

Climate Change Effects Vary by Region

Pacific Northwest

Reduced Snowpack
Increases in extreme precipitation events
Longer growing seasons
Warming could adversely affect wine, apples, and other tree crops with chilling requirements

Southwest

Greater uncertainty in water supply
Increased probability of heat stress to crops
Fire risk
Changes in plant diseases, pests, insects, and weeds
Specialty crop distributions

Northern Plains

New crops possible
Increased competition for water/irrigation
Changed crop growth cycles resulting from warmer winters
Rising temperatures /lengthen the growing season
Increase in precipitation extremes

Southern Plains

Increased drought
Increased temperature
Possible northward shift in crop production, Wildfire
Range quality

Higher temperatures
Reduced crop yields and milk production from heat stress
Extreme precipitation events
Longer growing season
Coastal Flooding

Northeast

Midwest

Extreme Rainfall/Flooding
Increased heat events
Growing seasons have lengthened by almost two weeks since 1950
Wetter springs/fewer workable field days

Southeast

Sea-Level Rise
Drought
Temperature increase
Spread of Nonnative Plants, Weeds, Pests
Increased insects and pathogens



Gulf of Mexico

Features of a Regional Approach to Climate Adaptation and Risk Management :

- Emphasize rural communities and economies and focus on working lands -
- production agriculture, grazing systems and forest lands;
- Support USDA programs and activities at the regional and local levels;
- Utilize the Cooperative Extension system – a partnership of USDA and the land-grant university system –as well as USDA service agencies (e.g. NRCS, FSA, RD)
- Deliver knowledge, tools and information to farmers, ranchers and foresters.
- Build upon the research and development expertise of USDA through ARS, FS R&D and ERS.

A regional approach should provide....

Technical Support:

- Supplement USDA agriculture and land management program delivery
- Deliver evidence-based agriculture and land management tools and strategies for climate change response
- Support applied research and development and innovation partnerships

Assessments and Forecasts:

- Perform periodic regional assessments of risk and vulnerability
- Provide usable and easily accessible regional data and climate change
- forecast services

Outreach and Education

- Provide outreach and extension to farmers, ranchers, and forest landowners
- Educate natural and agriculture resource managers climate change science and the vulnerability to agro-ecosystems and forests.

Groups we are interested in engaging....

- Land Grant Universities and Agricultural Extension Services
- Private Sector (companies addressing climate change adaptation and mitigation, and developing innovative tools and solutions for risk management, crop consultants, insurance companies, seed companies)
- State, local, and regional governments and agencies with natural resource and agriculture responsibilities
- NOAA and DOI regional climate change experts/institutions
- Non-profit sector (conservation groups, foundations, and others that provide assistance to landowners in addressing land management issues.)
- Allied efforts in Canada and Mexico